US012252659B2

(12) **United States Patent**
Thiebaut et al.

(10) **Patent No.: US 12,252,659 B2**
(45) **Date of Patent: *Mar. 18, 2025**

(54) **LUBRICATING COMPOSITION FOR IMPROVING FUEL ECO AND REDUCING FRICTION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/785,234**

(22) PCT Filed: **Dec. 17, 2020**

(86) PCT No.: **PCT/EP2020/086670**

§ 371 (c)(1),
(2) Date: **Jun. 14, 2022**

(87) PCT Pub. No.: **WO2021/122915**

PCT Pub. Date: **Jun. 24, 2021**

(65) **Prior Publication Data**

US 2023/0016314 A1 Jan. 19, 2023

(30) **Foreign Application Priority Data**

Dec. 20, 2019 (EP) 19306733

(51) **Int. Cl.**

C10M 125/22	(2006.01)
C10M 169/04	(2006.01)
C10N 20/00	(2006.01)
C10N 20/06	(2006.01)
C10N 30/00	(2006.01)
C10N 30/02	(2006.01)
C10N 40/25	(2006.01)

(52) **U.S. Cl.**

CPC ***C10M 125/22*** (2013.01); ***C10M 169/04*** (2013.01); *C10M 2201/14* (2013.01); *C10M 2203/003* (2013.01); *C10N 2020/06* (2013.01); *C10N 2020/061* (2020.05); *C10N 2030/02* (2013.01); *C10N 2030/54* (2020.05); *C10N 2040/25* (2013.01)

(58) **Field of Classification Search**

CPC C10M 125/22; C10M 169/04; C10M 2201/14; C10M 2203/003; C10M 2201/066; C10N 2020/06; C10N 2020/061; C10N 2030/02; C10N 2030/54

See application file for complete search history.

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(57) **ABSTRACT**

The present invention relates to a lubricating composition according to the classification of grade SAEJ300 defined by the formula (X) and W (Y), wherein X is 0 or 5; and Y is an integer ranging from 4 to 20 or X is 0 and Y is 30; said composition comprising at least:

at least a base oil; and

at least a Molybdenum or Tungsten chalcogenide nanoobject having an object size ranging from 0.1 to 500 nm and from 1 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject

A-X—B (I)

13 Claims, No Drawings

LUBRICATING COMPOSITION FOR IMPROVING FUEL ECO AND REDUCING FRICTION

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a U.S. National Phase Application under 35 U.S.C. § 371 of International Patent Application No. PCT/EP2020/086670 filed Dec. 17, 2020, which claims priority of European Patent Application No. 19306733.7 filed Dec. 20, 2019. The entire contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention concerns lubricant composition and their use. Especially, the present invention relates to lubricant compositions to reduce friction and improve fuel economy (FE) properties.

BACKGROUND

The developments of engines and of performances of the lubricating compositions for an engine are inexplicably linked. The more the engines have a complex design, the more the yield and the optimization of consumption are higher and the more the lubricating composition for an engine is in demand and should improve its performances.

Very high compression in the engine, greater piston temperatures, in particular in the area of the upper piston segment, modern valve controls and without any maintenance with hydraulic pushers, as well as very high temperatures in the engine space increasingly request lubricants for modern engines.

The conditions of use of gasoline engines and of diesel engines include both extremely short covered routes and long paths. Indeed, 80% of the paths of cars in Western Europe are less than 12 kilometers while vehicles cover yearly distances ranging up to 300,000 km.

The oil-change intervals are also very variable, from 5,000 km for certain small diesel engines, they may range up to 100,000 km on the diesel engines of modern utility vehicles.

The lubricating compositions for motor vehicles therefore have to have improved properties and performances.

Lubricating compositions for engines therefore should meet many goals which are sometimes contradictory. These goals ensue from five main functions of the lubricating compositions for engines which are lubrication, cooling, no leaking, anticorrosion protection and pressure transmission.

The lubrication of the parts sliding on each other plays a determining role, in particular for reducing friction and wear, notably allowing fuel savings.

Another essential requirement of lubricating compositions for engines relates to the aspects related to the environment. Indeed it has become essential to reduce the oil consumption as well as the fuel consumption, in particular with the purpose of reducing CO2 emissions. It is also important to reduce emissions of burnt gases, for example by formulating oils so that the catalyst remains perfectly functional during the whole of its lifetime. It is also important to limit or avoid the use of toxic additives in order to reduce or limit their removal, for example by reprocessing or by combustion.

The nature of the lubricating compositions for engines for automobiles has an influence on the emission of pollutants and on the fuel consumption. Lubricating compositions for engines for automobiles allow energy savings which are sometimes referred to as "fuel-eco" (FE). Such fuel-eco >oils were developed for meeting these new needs.

Reduction of energy losses is therefore a constant research in the field of lubricants for automobiles.

As regards the uses for lubrication of a vehicle engine, additives are also used.

As additives modifying the friction coefficient, organometal compounds, for example comprising molybdenum and notably molybdenum sulfide, are currently used. Mention may be made of molybdenum dithiocarbamates (MoDTC) as a majority source of molybdenum.

Moreover, different (co)polymers improving the viscosity index in a lubricating composition are also known.

There is thus a need to provide a lubricant composition enabling improved reduction of friction coefficient.

There is also a need to develop lubricant composition for improving FE.

SUMMARY

It is thus an object of the invention to provide a lubricating composition for which viscosity can be modulated, especially to be adapted to the mechanical part in contact to lubricate in a machine, preferably an engine.

It is also an object of the invention to provide such lubricating composition that enables a good level of fuel economy (FE) of an engine, in particular a vehicle engine.

Further objects of the invention will appear by reading the description of the invention that follows.

The present invention thus provides a lubricant composition according to the classification of grade SAEJ300 defined by the formula (X) and W (Y), wherein X is 0 or 5; and Y is an integer ranging from 4 to 20 or X is 0 and Y is 30; said composition comprising:

At least a base oil; and

At least a Molybdenum or Tungsten chalcogenide nanoobject having an object size ranging from 0.1 to 500 nm and from 1 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject

A-X—B (I)

wherein A is OH or SH;

X is a biradical selected from the group consisting of (C1-C20)alkyl; (C1-C20)alkyl substituted with one or more radicals independently selected from the group consisting of: (C1-C5)alkyl, —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyl radicals, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one of more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(O)R^3, —C(═O)(O^-), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)R^5, —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)R^2, —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)R^1, —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); a 2 to 20-member heteroalkyl; a 2 to 20-member heteroalkyl substituted with one or more radicals independently selected from the group consisting of: —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyls, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one or more (C1-C4)alkyls, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)(R^7), —OC(═O)(O)R^3, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4) (R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); and a homopolymer or copolymer comprising a polymeric chain selected from the group consisting of: alkyd resin, epoxy resin, phenolic resin, polyvinyl halides, polyacetal, polyacrylics, polyalkylenes, polyalkenylenes, polyalkynylenes, polyamic acids, polyamides, polyamines, polyanhydrides, polyarylenealkylenes, polyarylenes, polyazomethines, polybenzimidazoles, polybenzothiazoles, polybenzyls, polycarbodiimides, polycarbonates, polycarbones, polycarboranes, polycarbosilanes, polycyanurates, polydienes, polyester-polyurethanes, polyesters, polyetheretherketones, polyether-polyurethanes, polyethers, polyhydrazides, polyimidazoles, polyimides, polyisocyanurates, polyketones, polyolefines, polyoxyalkylenes, polyoxyphenylenes, polyphenyls, polyphosphazenes, polypyrroles, polypyrrones, polyquinolines, polyquinoxalines, polysilanes, polysilazanes, polysiloxanes, polysilsesquioxanes, polysulfides, polysulfonamides, polysulfones, polythiazoles, polythiomethylenes, polythiophenylenes, polyureas, polyurethanes, polyvinyl acetals, polyvinyl butyrals, polyvinyl formals, polyvinyl alkanoates, vinyl polymers, and natural polymers; B is a radical selected from the group consisting of: H, —OH, —NH_2, (C1-C4) alkyl, halogen, phenyl substituted with one or more halogen radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(O)R^3, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)(R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2);

provided that:

when B is H or (C1-C4)alkyl, then X is a 2 to 20-member heteroalkyl; a 2 to 20-member keteroalkyl substituted with one or more radicals, as defined above, or a homopolymer or copolymer, as defined above; and B is H or (C1-C4)alkyl when X is a homopolymer, copolymer, a 2 to 20-member heteroalkyl or a 2 to 20-member heteroalkyl substituted as defined above; and when B is —NH_2, then X is a biradical selected from the group consisting of (C1-C20)alkyl; (C1-C20)alkyl substituted with one or more radicals independently selected from the group consisting of: (C1-C5)alkyl, —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyl radicals, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one of more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(OR^3), —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)R^5, —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)R^2, —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)R^1, —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); a 2 to 20-member heteroalkyl; a 2 to 20-member heteroalkyl substituted with one or more radicals independently selected from the group consisting of: —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyls, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one or more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)(R^7), —OC(═O)(O)R^3, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)(R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR', —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2);

R^1, R^2, R^3, R^4, R^5 and R^6 are radicals independently selected from the group consisting of H, (C1-C20) alkyl, (C6-C12)aryl(C1-C20)alkyl and (C6-C12)aryl;

R^7 is halogen;

2 to 20-member heteroalkyl represents a known non-polymeric C-heteroalkyl radical consisting of from 2 to 20 members where at least one of the members is O, S or NH, and the remaining members are selected from CH, C(═O) and CH_2; and (C5-C12)aryl represents a ring system from 5 to 12 carbon atoms, the system comprising from 1 to 2 rings, where each one of the rings forming the ring system: is saturated, partially unsaturated or aromatic; and is isolated, partially or totally fused.

Preferably, the lubricant composition according to the invention is, according to the classification of grade SAEJ300, defined by the formula (X) and W (Y), wherein X is 0 or 5; and Y is an integer ranging from 4 to 20.

Preferably, the compound of formula (I) functionalizing the chalcogenide nano-object if of polar nature, either by the specific polar nature of A and B radicals, or by the specific polar nature of X when it is a homopolymer or copolymer as defined above.

Preferably, in the present invention,

A is OH;

X is a biradical selected from the group consisting of (C1-C20)alkyl; (C1-C20)alkyl substituted with one or more radicals independently selected from the group consisting of: (C1-C5)alkyl, —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyl radicals, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one of more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(O)R^3, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)R^5, —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)R^2, —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)R^1, —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); a 2 to 20-member heteroalkyl; a 2 to 20-member heteroalkyl substituted with one or more radicals independently selected from the group consisting of: —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyls, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one or more (C1-C4)alkyls, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)(R^7), —OC(═O)(O)R^3, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4) (R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); and a homopolymer or copolymer comprising a polymeric chain selected from the group consisting of: alkyd resin, epoxy resin, phenolic resin, polyvinyl halides, polyacetal, polyacrylics, polyalkylenes, polyalkenylenes, polyalkynylenes, polyamic acids, polyamides, polyamines, polyanhydrides, polyarylenealkylenes, polyarylenes, polyazomethines, polybenzimidazoles, polybenzothiazoles, polybenzyls, polycarbodiimides, polycarbonates, polycarbones, polycarboranes, polycarbosilanes, polycyanurates, polydienes, polyester-polyurethanes, polyesters, polyetheretherketones, polyether-polyurethanes, polyethers, polyhydrazides, polyimidazoles, polyimides, polyisocyanurates, polyketones, polyolefines, polyoxyalkylenes, polyoxyphenylenes, polyphenyls, polyphosphazenes, polypyrroles, polypyrrones, polyquinolines, polyquinoxalines, polysilanes, polysilazanes, polysiloxanes, polysilsesquioxanes, polysulfides, polysulfonamides, polysulfones, polythiazoles, polythiomethylenes, polythiophenylenes, polyureas, polyurethanes, polyvinyl acetals, polyvinyl butyrals, polyvinyl formals, polyvinyl alkanoates, vinyl polymers, and natural polymers; B is a radical selected from the group consisting of: H, —OH, halogen, phenyl substituted with one or more halogen radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(O)R^3, —C(═O)(O), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)(R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO,

—C_5H_4N, —SR^1, —SSR^1, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2).

The Molybdenum and Tungsten chalcogenide nano-object are as described in WO2016/156543. The process of preparation of such objects is also described in WO2016/156543. WO2016/156543 and the features disclosed in this document are hereby incorporated by reference.

In the present invention the term "nano-object" refers to a primary particle (non-agglomerated single particle) with one, two or three external dimensions in the nanoscale, as already recognized by International Organization for Standardization in the document with the reference number ISO/TS 27687:2008(E). Illustrative non-limitative examples of nano-objects are: nanoparticles, which are nanoobjects with all three external dimensions in the nanoscale (if the lengths of the longest to the shortest axes of the nanoobject differ significantly, typically by more than three times, the terms nanofiber or nanoplate are intended to be used instead of the term nanoparticle); nanosheets (or nanoplates or nanolayers), which are nanoobjects with one external dimension in the nanoscale and the two other external dimensions significantly larger, wherein the smallest external dimension is the thickness of the nanosheets, the two significantly larger dimensions are considered to differ from the nanoscale dimension by more than three times, and the larger external dimensions are not necessarily in the nanoscale; nanofibers, which are nanoobjects with two similar external dimensions in the nanoscale and the third dimension significantly larger, wherein the nanofibers can be flexible or rigid and the two similar external dimensions are considered to differ in size by less than three times and the significantly larger external dimension in considered to differ from the other two by more than three times, and the largest external dimension is not necessarily in the nanoscale; nanotubes, which are hollow nanofibers; nanorods, which are solid nanofibers; nanowires, which are electrically conducting or semi-conducting nanofibers; and quantum dots, which are crystalline nanoparticles exhibiting size-dependent properties due to quantum confinement effects on the electronic states.

The term "object size" when referred to the nanoobject of the invention refers to a characteristic physical dimension of the primary particle. For example, in the case of a spherical nanoobject, the "object size" corresponds to the diameter of the nanoobject. In the case of a rod-shaped nanoobject with a circular cross-section, as it is the case of a nanofiber (either as such or in the form of a nanowire or nanotube), the "object size" of the nanoobject corresponds to the diameter of the cross-section of the nanoobject. In the case of a box-shaped nanoobject, such as a nanosheet, nanocube, a nanobox, or a nanocage, the size of the nanoobject corresponds to the thickness. When referring to a set of nanoobjects being of a particular size, it is contemplated that the set of nanoobjects can have a distribution of sizes around the specified size.

The size of the nanoobjects of the invention can be determined using well-known techniques in the state of the art such as Transmission Electron Microscopy (TEM). Images were chosen to be as representative of bulk sample as possible. TEM observations were performed in a JEOL2010F operating with 200 KV accelerating voltage equipped with Energy Dispersive Spectroscopy (EDS). The measured dimension was chosen depending on the morphology of the nanoobject as described above.

In the present invention, the term "chalcogenide" means a chemical compound consisting of at least one chalcogen anion and at least one more electropositive element. In one embodiment, the chalcogenide is a sulfide, selenide or telluride.

In the present invention, the term "polymeric chain" means a molecule of high relative molecular mass, the structure of which essentially comprises the multiple repetitions of units derives, actually or conceptually, from molecules of low relative molecular mass.

In the present invention, the term "natural polymers" can be defined as naturally occurring polymers which are produced in living organism. The most important naturally occurring polymers are proteins, polysaccharides (e.g. cellulose, starch, and cotton), nucleic acids (e.g. DNA, RNA) and natural rubber.

According to the present invention, a ring system formed by "isolated" rings means that the ring system is formed by two rings and said rings are bound via a bond from the atom of one ring to the atom of the other ring. The term "isolated" also embraces the embodiment in which the ring system has only one ring. Illustrative non-limitative examples of known ring systems consisting of one ring are those derived from: cyclopropyl, cyclobutyl, yclopentyl, cyclohesyl, cycloheptyl, cyclopropenyl, cyclobutenyl, cyclopentenyl, phenyl, biphenyl and cycloheptenyl.

According to the present invention when the ring system has "totally fused" rings, it means that the ring system is formed by two rings in which two or more atoms are common to two adjoining rings. Illustrative non-limitative examples are 1,2,3,4-tetrahydronaphthyl, and 1-naphthyl, 2-naphthyl.

In the present invention, the term "(%) by weight" refers to the percentage of each ingredient of the nanoobject or composition in relation to the total weight. As it is explained in detail below, the % by weight of molecules of formula (I) in relation of the total weight of the nanoobject has been determined by Thermal gravimetric analysis (TGA).

Preferably, the metal chalcogenide is a Molybdenum chalcogenide of sulfide, selenide or telleride. More preferably, the metal chalcogenide is MoS_2.

DETAILED DESCRIPTION

In one embodiment, the nanoobject comprises from 15 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject. Preferably, the nanoobject comprises from 30 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, preferably from 40 to 99%, more preferably from 40 to 95% by weight of molecules of formula (I) with respect to the total weight of the nanoobject.

In another embodiment, X is a homopolymer or copolymer comprising a polymeric chain selected from the group consisting of: alkyd resin, epoxy resin, phenolic resin, polyvinyl halides, polyacetal, polyacrylics, polyalkylenes, polyalkenylenes, polyalkynylenes, polyamides, polyamines, polyanhydrides, polycarbonates, polyester-polyurethanes, polyesters, polyetheretherketones, polyether-polyurethanes, polyethers, polyimidazoles, polyimides, polyisocyanurates, polyketones, polyolefines, polyoxyalkylenes, polyoxyphenylenes, polypyrroles, polysiloxanes, polysulfides, polysulfonamides, polysulfones, polythiazoles, polythiomethylenes, polythiophenylenes, polyureas, polyurethanes, polyvinyl acetals, polyvinyl butyrals, polyvinyl formals polyvinyl alkanoates, vinyl polymers, and natural polymers. Preferably, X is a homopolymer or copolymer comprising a polymeric chain selected from the group consisting of: epoxy resin, phenolic resin, polyvinyl halides, polyacetal, polyacrylics, polyamides, polyamines, polycarbonates, polyester-polyurethanes, polyesters, polyether-polyurethanes, polyethers, polyimides, polyketones, polyolefines, polyoxyalkylenes, polyoxyphenylenes, polysiloxanes, polysulfides, polysulfones, polythiomethylenes, polyureas, polyurethanes, polyvinyl acetals, and polyvinyl alkanoates, and natural polymers. In a preferred embodiment X is a polyether. Illustrative non-limitative examples of polyethers are: polyoxymethylene (POM), polyacetal, polyethylene oxide (PEO), polypropylene oxide (PPO), polytetrahydrofuran (PTHF). In another preferred embodiment, X is a polyethylene oxide. In another preferred embodiment, X is a polyether, A is —OH, and B is selected from —H, and (C1-C4) alkyl.

In still another preferred embodiment, X is a polyether and A and B are —OH.

In another preferred embodiment the molecule of formula (I) is one wherein X is a biradical selected from the group consisting of: (C1-C10)alkyl; (C1-C10)alkyl substituted with one or more radicals as defined above; a 2 to 10-member heteroalkyl; a 2 to 10-member heteroalkyl substituted with one or more radicals as defined above; and a homopolymer or copolymer as defined above. In another embodiment, the compound of formula (I) is one wherein X is a biradical selected from the group consisting of: (C1-C10) alkyl; a 2 to 10-member heteroalkyl; and a 2 to 10-member heteroalkyl substituted with one or more (C1-C5)alkyl radicals. In another embodiment X is a biradical selected from the group consisting of: (C1-C10)alkyl; and 2 to 10-member heteroalkyl as defined in the first aspect of the invention above. In another embodiment X is a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members. In another embodiment X is selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members. In another embodiment X is selected from (C-1-C-10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members are CH2 members. In another embodiment X is selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them O members and the remaining being CH2 members. In another embodiment X is selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of the members NH, and the remaining being CH2 members.

In another embodiment the molecule of formula (I) is one wherein X is a biradical selected from the group consisting of: (C1-C6)alkyl; (C1-C6)alkyl substituted with one or more radicals as defined in the first aspect of the invention; a 2 to 6-member heteroalkyl; a 2 to 6-member heteroalkyl substituted with one or more radicals as defined above; and a homopolymer or copolymer as defined above. In another embodiment, the compound of formula (I) is one wherein X is a biradical selected from the group consisting of: (C1-C6)alkyl; a 2 to 6-member heteroalkyl; and a 2 to 6-member heteroalkyl substituted with one or more (C1-C5)alkyl radicals. In another embodiment X is a biradical selected from the group consisting of: (C1-C6)alkyl; and 2 to 6-member heteroalkyl as defined in the first aspect of the invention. In another embodiment X is a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members. In another embodiment X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members. In another embodiment X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members. In another embodiment X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them O member(s), and the remaining being CH2 members. In another embodiment X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them being a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when X is a biradical selected from the group consisting of: (C1-C20)alkyl; and 2 to 20-member heteroalkyl as defined above. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% of molecules of formula (I) with respect to the total weight of the nanoobject when X is (C-1-C10)alkyl, or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% of molecules of formula (I) with respect to the total weight of the nanoobject when X is (C1-C6)alkyl, or a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% of molecules of formula (I) with respect to the total weight of the nanoobject when X is (C1-C-10)alkyl or a 2 to 10-member heteroalkyl being at least one of the members selected from O, and NH, and the remaining being CH2 members. In another embodiment of the first aspect of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% of molecules of formula (I) with respect to the total weight of the nanoobject when X is (C1-C6)alkyl or a 2 to 6-member heteroalkyl being at least one of the members selected from O, and NH, and the remaining being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when X is selected from (C1-C-10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (1) with respect to the total weight of the nanoobject when X is selected from (C1-C-10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them being O member(s), and the remaining being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them being O member(s), and the remaining being CH2 members. In another embodiment of the first aspect of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when X is selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of them a NH member, and the remaining being CH2 members. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (1) with respect to the total weight of the nanoobject when X is selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them a NH member, and the remaining being CH2 members.

In the present invention, the expression "have(has) from" has the same meaning as "comprise(s) from".

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when X is a homopolymer or copolymer, as defined above. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when X is a homopolymer or copolymer comprising a polyether polymeric chain. In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nannoobject when X is a homopolymer or copolymer comprising a polyethylene oxide polymeric chain.

In another embodiment of the invention, B is a radical selected from the group consisting of: H, —NH_2, (C1-C4) alkyl, —OH, halogen, phenyl substituted with one or more halogen radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —OC(═O)(O)R^3, —C(═O)(O^-), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OH), —C(OR^3)(OH)(R^4), —CH(OR^3)(OR^4), NR^1R^2, N+$R^1R^2R^3$, —C(═NR^1)(H), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N (pyridyl), —SR^1, —SSR^3, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(H), —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —B(OH), —B(OR^1)(OR^2), and —B(OH)R^1).

In another embodiment, B is a radical selected from the group consisting of: H, —NH_2, (C1-C4)alkyl, OH, halogen, phenyl substituted with one or more halogen radicals, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —NR^1R^2, N+$R^1R^2R^3$, —C(═O)(NR^1R^2), —ONO_2, —CN (nitrile), —NC, —NO_2, —NO, —C_5H_4N, —SR^1, —S(═O)(═O)(R^1), —S(═O)(═O)(OH), —OP(═O)$(OH)_2$, —B(OH) and —B(OH)R^1). In still another embodiment B is H, —NH_2, (C1-C4)alkyl, or OH.

In another embodiment of the invention, B is a radical selected from the group consisting of: H, —OH, halogen, phenyl substituted with one or more halogen radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —OC(═O)(O)R^3, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OH), —C(OR^3)(OH)(R^4), —CH(OR^3)(OR^4), NR^1R^2, N+$R^1R^2R^3$, —O(═NR^1)(H), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N (pyridyl), —SR^1, —SSR3, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(H), —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —B(OH), —B(OR^1)(OR^2), and —B(OH)(R^1). In another embodiment, B is a radical selected from the group consisting of: H, OH, halogen, phenyl substituted with one or more halogen radicals, —C(═O)(O—), —C(═O)(O)R^3, —OR^3, NR^1R^2, N+$R^1R^2R^3$, —C(═O)(NR^1R^2), —ONO_2, —CN (nitrile), —NC, —NO_2, —NO, —C_5H_4N, —SR^1, —S(═O)(═O)(R^1), —S(═O)(═O)(OH), —OP(═O)$(OH)_2$, —B(OH) and —B(OHR^1). In still another embodiment B is H or OH.

In one embodiment of the invention, the molecule of formula (I) is one wherein R^1, R^2, R^3, R^4, R^5, and R^6 are radicals independently selected from the group consisting of H, (C—C10)alkyl, (C6-C-12)aryl(C1-C10)alkyl and (C6-C12)aryl. In another embodiment of the first aspect of the invention, the molecule of formula (I) is one wherein R^1, R^2, R^3, R^4, R^5, and R^6 are radicals independently selected from the group consisting of H, (C1-C3)alkyl, (C6-C12)aryl(C1-C3)alkyl and (C6-C12)aryl.

In another embodiment of the invention, the molecule of formula (I) is one where A represents —OH, and B and X are as defined in any of the above embodiments.

In another embodiment of the invention, the molecule of formula (I) is one wherein A represents —OH, B is H, OH, —NH_2, or (C1-C4)alkyl, and X is as defined in any of the above embodiments. In another embodiment of the invention, the molecule of formula (I) is one wherein B is —OH or H, and A and X are as defined in any of the above embodiments.

In another embodiment of the invention, the molecule of formula (I) is one wherein A represents —OH, B is —OH or H, and X is as defined in any of the above embodiments.

In another embodiment, the molecule of formula (I) is one selected from the group consisting of propylene glycol, ethylene glycol, diethylene glycol, polyethylene glycol, diethanolamine, 1,6-hexanediol, polyethyleneglycolmonomethyl ether, and 6-amino-1-hexanol.

In another embodiment, the molecule of formula (I) is one selected from the group consisting of propylene glycol, ethylene glycol, diethylene glycol, polyethylene glycol, diethanolamine, and 1,6-hexanediol.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is a biradical selected from the group consisting of: (C1-C20) alkyl; and 2 to 20-member heteroalkyl as defined above.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is selected from (C1-C10)alkyl and a 2 to 10- member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is selected from (C1-C6)alkyl and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH2, (C C4)alkyl, —OH or H, and X is selected from (C1-C10)alkyl or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members.

In another embodiment the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is selected from (C1-C6)alkyl or a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, OH, or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, OH, H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is a biradical X selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, OH, or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of them being a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —NH_2, (C1-C4)alkyl, —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them being a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from the group consisting of: (C1-C20)alkyl; and 2 to 20-member heteroalkyl as defined above.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is selected from (C-1-C10)alkyl and a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members. In another embodiment of the first aspect of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is selected from (C1-C6)alkyl and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is selected from (C1-C10)alkyl or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members.

In another embodiment the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is selected from (C1-C6)alkyl or a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the first aspect of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical X selected from (C1-C6)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical X selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the first aspect of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of them being a NH member, and the remaining members being CH2 members.

In another embodiment of the first aspect of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them being a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH, B is (C1-C4)alkyl, —OH or H, and X is a homopolymer or copolymer as defined above.

In another embodiment, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4)alkyl, —OH or H, and X is copolymer or homopolymer comprising a polyether chain.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 15 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH, B is (C1-C4)alkyl, —OH or H, and X is a homopolymer or copolymer comprising a polyethylene oxide chain.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH or —SH, B is —OH or H, and X is a homopolymer or copolymer as defined above.

In another embodiment, the nanoobject comprises from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is copolymer or homopolymer comprising a polyether chain.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH or —SH, B is —OH or H, and X is a homopolymer or copolymer comprising a polyethylene oxide chain.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from the group consisting of: (C1-C20)alkyl; and 2 to 20-member heteroalkyl as defined above.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is selected from (C1-C10)alkyl and a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is selected from (C1-C6)alkyl and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members being CH2 members.

In another embodiment the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is selected from (C1-C10)alkyl or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members are CH2 members.

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In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6- member heteroalkyl having from 2 to 6 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H; and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H; and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6- member heteroalkyl having from 2 to 6 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH, B is —OH or H, and X is a homopolymer or copolymer as defined above. In another embodiment, the nanoobject comprises from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is copolymer or homopolymer comprising a polyether chain.

In another embodiment of the invention, the nanoobject comprises from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH, B is —OH or H, and X is a homopolymer or copolymer comprising a polyethylene oxide chain.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4)alkyl, NH_2, —OH or H, and X is a biradical selected from the group consisting of: (C1-C20)alkyl; and 2 to 20-member heteroalkyl as defined above.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H; and X is selected from (C1-C10)alkyl and a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H; and X is selected from (C1-C6)alkyl and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H, and X is selected from (C1-C10)alkyl or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members being CH2 members.

In another embodiment the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H; and X is selected from (C1-C6)alkyl or a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, and NH, and the remaining members being CH2 members. In another embodiment of the first aspect of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H, and X is a biradical X selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H, and X is a biradical X selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them a O member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4), NH_2, —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 15 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is (C1-C4)alkyl, NH_2, —OH or H; and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from the group consisting of: (C1-C20)alkyl; and 2 to 20-member heteroalkyl as defined above.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H; and X is selected from (C1-C10)alkyl and a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H; and X is selected from (C1-C6)alkyl and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members are CH2 members.

In another embodiment the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is selected from (C1-C10) alkyl or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members being CH2 members.

In another embodiment the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H; and X is selected from (C1-C6)alkyl or a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when:

A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical X selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical X selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them a O member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H; and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH or —SH, B is —OH or H, and X is a homopolymer or copolymer as defined above.

In another embodiment, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH or —SH, B is —OH or H, and X is copolymer or homopolymer comprising a polyether chain.

In another embodiment of the first aspect of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH or —SH, B is —OH or H, and X is a homopolymer or copolymer comprising a polyethylene oxide chain.

In another embodiment of the first aspect of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from the group consisting of: (C1-C20)alkyl; and 2 to 20-member heteroalkyl as defined above.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is selected from (C1-C10)alkyl and a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, S, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is selected from (C1-C6)alkyl and a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, S, and NH, and the remaining members being CH2 members.

In another embodiment the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is selected from (C1-C10)alkyl or a 2 to 10-member heteroalkyl having from 2 to 10 members, being at least one of the members selected from O, and NH, and the remaining members being CH2 members.

In another embodiment the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H; and X is selected from (C1-C6)alkyl or a 2 to 6-member heteroalkyl having from 2 to 6 members, being at least one of the members selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of the members independently selected from O, and NH, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10-member heteroalkyl having from 2 to 10 members, being one or two of them O member(s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one or two of them O member (s), and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is a biradical selected from (C1-C10)alkyl, and a 2 to 10- member heteroalkyl having from 2 to 10 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 20 to 80% or from 30 to 70% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H; and X is a biradical selected from (C1-C6)alkyl, and a 2 to 6-member heteroalkyl having from 2 to 6 members, being one of them a NH member, and the remaining members being CH2 members.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH, B is —OH or H, and X is a homopolymer or copolymer as defined above.

In another embodiment, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject, when: A is —OH, B is —OH or H, and X is copolymer or homopolymer comprising a polyether chain.

In another embodiment of the invention, the nanoobject is a MoS_2 nanoobject comprising from 1 to 99%, from 30 to 99% or from 90 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject when: A is —OH, B is —OH or H, and X is a homopolymer or copolymer comprising a polyethylene oxide chain.

In another embodiment of the invention the object size ranges from 0.1 to 500 nm.

In another embodiment, when the nanoobject is spherical, the object size ranges from 10 to 500 nm, from 20 to 250 nm or from 30 to 100 nm. In another embodiment, when the nanoobject has box-shape, the object size ranges from 0.1 to 50 nm, from 0.2 to 30 nm or from 0.3 to 15 nm. In another embodiment, when the nanoobject has rod-shape, the object size ranges from 1 to 100 nm, from 5 to 50 nm or from 10 to 30 nm.

In another embodiment of the invention, the nanoobject comprises a single type of molecule of formula (I). This means, for instance, that the surface of the nanoobject is functionalized with uniquely propylene glycol molecules, or alternatively by ethylene glycol molecules, or alternatively by diethylene glycol molecules, or alternatively by polyethylene glycol molecules, or alternatively by polyethylene glycol monomethyl ether, or alternatively by diethanolamine molecules, or alternatively by 1,6-hexanediol molecules, or alternatively by 6-amino-1-hexanol molecules.

In another embodiment of the invention, the surface the nanoobject comprises different molecules of formula (I). This means that the surface of the nanoobject can be functionalized with a mixture of two or more different molecules of formula (I), such as propylene glycol molecules plus diethylene glycol molecules, or polyethylene glycol molecules plus 1,6-hexanediol molecules.

Preferably, the nanoobject of the invention is MoS_2 functionalized with polyalkylene glycol, preferably polyethylene glycol (PEG), particularly polyethylene glycol of molecular weight 10000) (PEG10000).

In a specific embodiment, the polyethylene glycol represents between 60 and 99% of the total weight content of the nanoobject. Preferably, the polyethylene glycol represents 94% of the total weight content of the nanoobject.

Eventually, in an alternative embodiment, the lubricant composition according to the invention may comprise two kinds of nanoobjects as defined above.

The composition of the invention is defined by the formula (X) W (Y), wherein X is 0 or 5; and Y is an integer ranging from 4 to 20 or X is 0 and Y is 30, according to the classification of grade SAEJ300. Preferably the composition of the invention is equal or lower than a OW-30 grade type, preferably is defined by the formula (X) W (Y), wherein X is 0 or 5; and Y is an integer ranging from 4 to 20, according to the classification of grade SAEJ300; preferably a 0W-12 grade type. Lubricant composition of 0W-12 grade type are well known for the skilled person. Typically, lubricant composition of 0W-12 has a kinematic viscosity measured at 100° C. higher or equal to 5 mm^2/s and less than 7.1 mm^2/s.

The kinematic viscosity can be measured according to ASTM D445 standard.

The base oils used in the lubricant compositions according to the invention may be oils of mineral or synthetic origins belonging to the groups I to V according to the classes defined by the API classification (or their equivalents according to the ATIEL classification) (table A) or mixtures thereof.

TABLE A

	Contents of saturated substances	Sulfur content	Viscosity index (VI)
Group I Mineral oils	<90%	>0.03%	$80 \leq VI < 120$
Group II Hydrocracked oils	≥90%	≤0.03%	$80 \leq VI < 120$
Group III Hydrocracked or hydro-isomerized oils	≥90%	≤0.03%	≥120
Group IV	Polyalphaolefins (PAO)		
Group V	Esters and other bases not included in the groups I to IV		

The mineral base oils according to the invention include all types of bases obtained by atmospheric and in vacuo distillation of crude oil, followed by refining operations such as extraction with a solvent, de-asphalting, de-waxing with a solvent, hydro-treatment, hydrocracking, hydroisomerization and hydrofinishing.

Mixtures of synthetic and mineral oils may also be used.

The base oils of the lubricant compositions according to the invention may also be selected from among synthetic oils, such as certain esters of carboxylic acids and of alcohols, and from among polyalphaolefins. The polyalphaolefins used as base oils are for example obtained from monomers comprising from 4 to 32 carbon atoms, for example from octene or decene, and for which the viscosity at 100° C. is comprised between 1.5 and 15 $mm^2.s$-according to the ASTM D445 standard. Their average molecular mass is generally comprised between 250 and 3,000 according to the ASTM D5296 standard.

The lubricating composition according to the invention may comprise at least 50% by volume of base oils based on the total mass of the composition. More advantageously, the lubricant composition according to the invention comprises at least 60% by volume, or even at least 70% by volume, of base oils based on the total volume of the composition. In a more particularly advantageous way, the lubricant composition according to the invention comprises from 75 to 97% by volume of base oils based on the total mass of the composition.

The composition of the invention can also comprise at least one additive.

Many additives may be used for this lubricant composition according to the invention.

The preferred additives for the lubricant composition according to the invention are selected from among detergent additives, anti-wear additives, friction modifier additives different from nanoobject described above, extreme pressure additives, dispersants, enhancers of the pour point, anti-foam agents, thickeners and mixtures thereof.

Preferably, the lubricant composition according to the invention comprises at least one anti-wear additive, at least one extreme pressure additive or mixtures thereof.

The anti-wear additives and the extreme pressure additives protect the friction surfaces by forming a protective film adsorbed on these surfaces.

There exist a large variety of anti-wear additives. Preferably for the lubricant composition according to the invention, the anti-wear additives are selected from among phosphorus-sulfur-containing additives like metal alkylthiophosphates, in particular zinc alkylthiophosphates, and more specifically zinc dialkyldithiophosphates or ZnDTP. The preferred compounds are of formula $Zn((SP(S)(OR)(OR))_2$, wherein R and R', either identical or different, represent independently an alkyl group, preferentially an alkyl group including from 1 to 18 carbon atoms.

The amine phosphates are also anti-wear additives which may be used in the lubricant composition according to the invention. However, the phosphorus brought by these additives may act as a poison of catalytic systems of automobiles since these additives are ash generators. It is possible to minimize these effects by partly substituting the amine phosphates with additives not providing any phosphorus, such as for example, polysulfides, notably sulfur-containing olefins.

Advantageously, the lubricant composition according to the invention may comprise from 0.01 to 6% by mass, preferentially from 0.05 to 4% by mass, more preferentially from 0.1 to 2% by mass based on the total mass of lubricant composition, of anti-wear additives and extreme pressure additives.

Advantageously, the lubricant composition according to the invention may also comprise at least one friction modifier additive different from the nanoobject of the invention. The friction modifier additive may be selected from among a compound providing metal elements and a compound free of ashes. Among the compounds providing metal elements, mention may be made of complexes of transition metals such as Mo, Sb, Sn, Fe, Cu, Zn for which the ligands may be hydrocarbon compounds comprising oxygen, nitrogen, sulfur or phosphorus atoms. The friction modifier additives free of ashes are generally of organic origin and may be selected from among fatty acid monoesters and from polyols, alkoxylated amines, alkoxylated fatty amines, fatty epoxides, borate fatty epoxides; fatty amines or esters of fatty acid glycerol. According to the invention, the fatty compounds comprise at least one hydrocarbon group comprising from 10 to 24 carbon atoms.

Advantageously, the lubricant composition according to the invention may comprise from 0.01 to 2% by mass or from 0.01 to 5% by mass, preferentially from 0.1 to 1.5% by mass or from 0.1 to 2% by mass based on the total mass of the lubricant composition, of a friction modifier additive different from the nanoobject of the invention.

Advantageously, the lubricating composition (or lubricant composition) according to the invention may comprise at least one antioxidant additive.

The antioxidant additive may generally delay the degradation of the lubricant composition being used. This degradation may notably be expressed by the formation of deposits, by the presence of sludges or by an increase in the viscosity of the lubricant composition.

The antioxidant additives notably act as radical inhibitors or hydroperoxide destructive inhibitors. From among the currently used antioxidant additives, mention may be made of the antioxidant additives of the phenolic type, of the antioxidant additives of the aminated type, of the phosphorus-sulfur-containing antioxidant additives. Certain of these antioxidant additives, for example the phosphorus-sulfur-containing antioxidant additives may be generators of ashes. The antioxidant phenolic additives may be free of ashes or else be in the form of metal salts either neutral or basic. The antioxidant additives may notably be selected from among sterically hindered phenols, sterically hindered phenol esters and sterically hindered phenols comprising a thioether bridge, diphenylamines, diphenylamines substituted with at least one C_1-C_{12} alkyl group, N,N'-dialkyl-aryl-diamines and mixtures thereof.

Preferably according to the invention, the sterically hindered phenols are selected from among the compounds comprising a phenol group for which at least one carbon in the neighborhood of the carbon bearing the alcohol function is substituted with at least one C_1-C_{10} alkyl group, preferably a C_1-C_6 alkyl group, preferably a C_4alkyl group, preferably by the ter-butyl group.

The aminated compounds are another class of antioxidant additives which may be used, optionally in combination with phenolic antioxidant additives. Examples of aminated compounds are aromatic amines, for example aromatic amines of formula $NR^aR^bR^c$ wherein Ra represents an aliphatic group or an aromatic group, optionally substituted, R^b represents an aromatic group, optionally substituted, R^c represents a hydrogen atom, an alkyl group, an aryl group or a group of formula $R^dS(O)_zR^e$ wherein R^d represents an alkylene group or an alkenylene group, R^e represents an alkyl group, an alkenyl group or an aryl group and z represents 0, 1 or 2.

Sulfur-containing phenol alkyls or their alkaline metal and earth-alkaline metal salts may also be used as antioxidant additives.

Another class of antioxidant additives is that of copper-containing compounds, for examples copper thio- or dithiophosphates, copper salts and of carboxylic acids, dithiocarbamates, sulphonates, phenates, copper acetylacetonates. The copper salts I and II, salts of succinic acid or anhydride may also be used.

The lubricant composition according to the invention may contain any types of antioxidant additives known to one skilled in the art.

Advantageously, the lubricant composition comprises at least one antioxidant additive free of ashes.

Also advantageously, the lubricant composition according to the invention comprises from 0.1 to 2% by weight based on the total mass of the composition, of at least one antioxidant additive.

The lubricant composition according to the invention may also comprise at least one detergent additive.

Detergent additives generally give the possibility of reducing the formation of deposits at the surface of metal parts by dissolving secondary oxidation and combustion products.

The detergent additives which may be used in the lubricant composition according to the invention are generally known to one skilled in the art. The detergent additives may be anionic compounds comprising a long lipophilic hydrocarbon chain and a hydrophilic head. The associated cation may be a metal cation of an alkaline or earth-alkaline metal.

The detergent additives are preferentially selected from among salts of alkaline metals or of earth-alkaline metals of carboxylic acids, sulfonates, salicylates, naphthenates, as well as salts of phenates. The alkaline and earth-alkaline metals are preferentially calcium, magnesium, sodium or barium.

These metal salts generally comprise the metal in a stoichiometric amount or else in an excess amount, therefore in an amount greater than the stoichiometric amount. These are then overbased detergent additives; the excess metal providing the overbased nature to the detergent additive is then generally in the form of a metal salt insoluble in oil, for example a carbonate, a hydroxide, an oxalate, an acetate, a glutamate, preferentially a carbonate.

Advantageously, the lubricant composition according to the invention may comprise from 0.5 to 8% or from 2 to 4% by weight of a detergent additive based on the total mass of the lubricant composition.

Also advantageously, the lubricant composition according to the invention may also comprise at least one pour point lowering additive.

By slowing down the formation of paraffin crystals, the pour point lowering additives generally improve the cold behavior of the lubricant composition according to the invention.

As an example of pour point lowering additives, mention may be made of alkyl polymethacrylates, polyacrylates, polyarylamides, polyalkylphenols, polyalkylnaphthalenes, alkyl polystyrenes.

Advantageously, the lubricant composition according to the invention may also comprise a dispersant agent.

The dispersant agent may be selected from among Mannich bases, succinimides and derivatives thereof.

Also advantageously, the lubricant composition according to the invention may comprise from 0.2 to 10% by mass of a dispersant agent based on the total mass of the lubricant composition.

Advantageously, the lubricant composition may also comprise at least one additional polymer improving the viscosity index. As examples of an additional polymer improving the viscosity index, mention may be made of polymeric esters, homopolymers or copolymers, either hydrogenated or not, hydrogenated, of styrene, of butadiene and of isoprene, polymethacrylates (PMA). Also advantageously, the lubricant composition according to the invention may comprise from 1 to 15% by mass based on the total mass of the lubricant polymeric composition improving the viscosity index.

The lubricant composition according to the invention may also comprise at least one thickener agent.

The lubricant composition according to the invention may also comprise antifoam agent and demulsifying agent.

Preferably, the lubricant composition according to the invention comprises:

At least a base oil;

0.01 to 15%, preferably from 0.1 to 5%, by weight, based on the total weight of the lubricant composition, of active ingredient of nanoobject according to the invention;

Preferably, the lubricant composition according to the invention comprises:

At least a base oil;

0.01 to 15%, preferably from 0.1 to 5%, by weight, based on the total weight of the lubricant composition, of active ingredient of nanoobject according to the invention;

At least a dispersant.

According to an embodiment, the lubricant composition according to the invention comprises, based on the total weight of the lubricant composition:

At least 50% by weight, preferably from 60 to 98% by weight, more preferably from 70 to 95% by weight, of base oil(s);

from 0.1 to 5% by weight, preferably from 1 to 3% by weight, of active ingredient of nanoobject according to the invention,

from 0.01 to 5% by weight of dispersant(s), preferably from 0.1 to 3% by weight, of dispersant(s),

Optionally from 0.01 to 30% by weight, preferably from 0.1 to 20% by weight of additive(s) other than the nanoobjects of the invention and other than dispersants.

According to an embodiment, the kinematic viscosity at 100° C. of the lubricant composition of the invention ranges from 1.5 to less than 9.9 mm^2/s, preferably equal or less than 9.3 mm^2/s, more preferably from 1.5 to 9.3 mm^2/s, preferably from 1.5 to less than 9.3 mm^2/s, preferably from 5.5 to 6.5 mm^2/s.

The presence of the nanoobject according to the invention in a lubricant composition of 0W-12 type enables an important decrease of the friction coefficient and an important improvement of the FE.

The inventors have also surprisingly found that the addition of the nanoobject according to the invention to a lubricating composition of 0W-12 grade type, with at least one dispersant and optionally other additives as described above, enables to obtain a low friction coefficient despite the presence of the dispersant and even if the amount of dispersant is high.

The inventors have also surprisingly found that the addition of the nanoobject according to the invention to a lubricating composition of 0W-12 type enables to use fluid oil in engine in order to maximize the FE.

The present invention also relates to the use of a lubricating composition according to the invention for reducing friction of mechanical parts in an engine.

The present invention also relates to a process for reducing frictions of mechanical parts in an engine comprising at least one step of bringing the mechanical parts of the engine into contact with the lubricant composition according to the invention.

The present invention also relates to the use of a lubricating composition according to the invention for reducing fuel consumption of an engine.

The present invention also relates to a process for reducing fuel consumption of an engine comprising at least one step of bringing the mechanical parts of the engine into contact with the lubricant composition according to the invention.

The present invention also relates to the use of a lubricating composition according to the invention to improve FE of an engine.

The present invention also relates to a process to improve FE of an engine comprising at least one step of bringing the mechanical parts of the engine into contact with the lubricant composition according to the invention.

The engine of the invention can be a 2-stroke engine or a 4-stroke engine, it is preferably a vehicle engine.

The present invention also relates to the use of nanoobject as defined above to improve the FE properties of a lubricant composition, preferably a lubricant composition of 0W-12 type fully formulated, i.e formulated with additives.

More particularly, the present invention is directed to the use of nanoobject as defined in the present invention, in particular MoS_2 functionalized with polyalkylene glycol, preferably with polyethylene glycol, to improve the FE properties of a lubricant composition of 0W-12 grade type and at least one dispersant.

The lubricant composition implemented in the use of nanoobject of the invention can have one or more of the specific embodiments described above in relation to the lubricant composition of the invention.

The invention will now be described with the following non-limiting examples.

Example 1: Nanoobject of the Invention

Synthesis of MoS20D nanoobjects functionalized with DEG.

A total amount of 0.05 mmol of sodium molybdate and 0.28 mmol of thiourea were stirred in 7.68 ml of diethylene glycol (DEG) under air atmosphere at 220° C. for 180 min.

After that, the reactor was quenched to room temperature and nanoobjects were isolated and purified. To remove the excess of reactants, solvent and co-products, the samples were washed by centrifugation: two times with ethanol, another two times with pure water and finally were washed one time with ethanol. Finally, the nanoobjects were dried at room temperature.

This synthesis corresponds to example 1 of WO2016156543.

The organic content of the 0D nanoobjects was about 46% (weight).

Example 2: Lubricating Composition

Lubricating composition according to the invention and comparative lubricating composition that does not comprise nano-objects or nano-objects different from the invention have been prepared.

The coefficients of friction of these compositions have been measured after 30 min and after 3 hours following the HFRR tribological tests.

The HFRR (High Frequency Reciprocating Rig) test is carried out on a PCS Instruments HFR. The test consists in a pure-sliding reciprocating motion between a diameter 6 mm ball and a flat, with a maximum contact pressure of 1.4 GPa.

The conditions of the tests are the following:

Load (N): 10

Maximum hertzian pressure (GPa): 1.4

Stroke length (mm): 1

Frequency (Hz): 10

Cycles: 144000

Oil capacity (ml): 2

IF-MoS2 concentration (wt %): 1

Temperature (° C.): 80.

The contact pressure and the very low surface separation are typical of the severe boundary lubrication met in automotive applications, such as gears or the valve train.

The results are given below:

	Fully formulated KV100 9.3 (base oil 0W30)		
Base Nano-objects	No nano-object	MoDTC (400 ppm of elementary Mo)	Nano-object according to the invention (1% by weight)
Coefficient of Friction after 30 min	0.12	0.05	0.05
Coefficient of Friction after 3 hours	0.12	0.09	0.05

*An Investigation on the Reduced Ability of IF-MoS2 Nanoparticles to Reduce Friction and Wear in the Presence of Dispersants, Tribology Letters 55(3):503-516. September 2014 The following compositions according to the invention were prepared by mixing the different component namely the base oil, the nanoobject, the MoDTC.

	CC1 0W30	CC2 0W20	CC3 0W12	CC4 0W30	CC5 0W20	CC6 0W12	CL3 0W30	CL1 0W20	CL2 0W12
Base oil (KV100)	9.876	8.321	6.015	9.876	8.321	6.015	9.876	8.321	6.015
HTHS	2.93	2.69	2.12	2.93	2.69	2.12	2.93	2.69	2.12
Nanoobject of this patent	/	/	/	/	/	/	1% w	1% w	1% w
Modtc S525	/	/	/	0.7% w	0.7% w	0.7% w	/	/	/

The engine used in these tests is a Renault R9M 4-stroke engine of 1598 cm3 over-fed of 130 horses for a maximum couple of 320 Nm. It is equipped with a common rail injection system and a turbo of variable geometry. The distribution uses pawl. This engine meets the requirement of the norm Euro6b norm.

The sequence is repeated 6 times in NDEC and 6 times in WLTC. An assay uses 15 liters of lubricating composition (7.5 for the assay and 7.5 for rinsing).

The gain in FE is calculated with reference to the OW-30 composition without friction modifier.

The results are given in table 3 below for WLTC cycle.

TABLE 3

	Gain FE vs 0W-30 composition without friction modifier (%)				
Composition	Low	Middle	High	Extra High	Average
CC4	0	0.1	0.2	0.3	0.2
CL3	0.3	0.3	0.4	0.4	0.4
CC5	0.5	0.5	0.5	0.5	0.5
CL1	1	0.6	0.6	0.4	0.6

TABLE 3-continued

	Gain FE vs 0W-30 composition without friction modifier (%)				
Composition	Low	Middle	High	Extra High	Average
CC6	0.7	0.8	0.6	0.4	0.6
CL2	2.3	1.5	1.2	0.7	1.1

The results show that with fluid grade oil the gain in FE is greater than with the other oil and is two times greater with the nanoobject of the invention than with MoDTC (usual friction modifier).

These results show the synergism between the 0W-12 grade composition and the nanoobject of the invention.

Moreover, the results show that with MoDTC in order to improve the friction coefficient it is necessary to increase the amount of MoDTC but increasing the Mo content leads to corrosion and sedimentation at low temperature. On the contrary the nanoobject of the invention can be used in greater amounts without negative effects on the lubricating composition.

The invention claimed is:

1. A lubricant composition being of 0W-12 grade type according to the classification of grade SAEJ300; said composition comprising:

at least a base oil; and

at least a Molybdenum or Tungsten chalcogenide nanoobject having an object size ranging from 0.1 to 500 nm and from 1 to 99% by weight of molecules of formula (I) with respect to the total weight of the nanoobject

A-X—B (I)

wherein A is OH or SH;

X is a biradical selected from the group consisting of (C1-C20)alkyl; (C1-C20)alkyl substituted with one or more radicals independently selected from the group consisting of: (C1-C5)alkyl, —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyl radicals, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one of more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(O)R^3, —C(═O)(O~), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)R^5, —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —$N^+R^1R^2R^3$, —C(═NR^1)R^2, —C(═O)(NR^1R^2), —N(C(═O)(R'))(C(═O)(R^2))(R^3), —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)R^1, —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); a 2 to 20-member heteroalkyl; a 2 to 20-member heteroalkyl substituted with one or more radicals independently selected from the group consisting of: —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyls, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one or more (C1-C4)alkyls, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)(R^7), —OC(═O)(O)R^3, —C(═O)(O~), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4) (R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N*$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3), —O(CN), —NC(O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); and a homopolymer or copolymer comprising a polymeric chain selected from the group consisting of: alkyd resin, epoxy resin, phenolic resin, polyvinyl halides, polyacetal, polyacrylics, polyalkylenes, polyalkenylenes, polyalkynylenes, polyamic acids, polyamides, polyamines, polyanhydrides, polyarylenealkylenes, polyarylenes, polyazomethines, polybenzimidazoles, polybenzothiazoles, polybenzyls, polycarbodiimides, polycarbonates, polycarbones, polycarboranes, polycarbosilanes, polycyanurates, polydienes, polyester-polyuréthanes, polyesters, polyetheretherketones, polyether-polyurethanes, polyethers, polyhydrazides, polyimidazoles, polyimides, polyisocyanurates, polyketones, polyolefines, polyoxyalkylenes, polyoxyphenylenes, polyphenyls, polyphosphazenes, polypyrroles, polypyrrones, polyquinolines, polyquinoxalines, polysilanes, polysilazanes, polysiloxanes, polysilsesquioxanes, polysulfides, polysulfonamides, polysulfones, polythiazoles, polythiomethylenes, polythiophenylenes, polyureas, polyurethanes, polyvinyl acetals, polyvinyl butyrals, polyvinyl formals, polyvinyl alkanoates, vinyl polymers, and natural polymers;

B is a radical selected from the group consisting of: H, —OH, —NH_2, (C1-C4)alkyl, halogen, phenyl substituted with one or more halogen radicals, benzyl substituted with one or more halogen radicals, —C(═O)R^3, —C(═O)R^7, —OC(═O)(O)R^3, —C(═O)(O~), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)(R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(═NR^1)(R^2), —C(═O)(NR^1R^2), —N(C(═O)(R^1))(C(═O)(R^2))(R^3) —O(CN), —NC(═O), —ONO_2, —CN, —NC, —ON(═O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(═O)(R^1), —S(═O)(═O)(R^1), —S(═O)(OH), —S(═O)(═O)(OH), —SCN, —NCS, —C(═S)(R^1), —PR^1R^2, —P(═O)$(OH)_2$, —OP(═O)$(OH)_2$, —OP(═O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2);

provided that:

when B is H or (C1-C4)alkyl, then X is a 2 to 20-member heteroalkyl; a 2 to 20-member keteroalkyl substituted with one or more radicals, as defined above, or a homopolymer or copolymer, as defined above; and

B is H or (C1-C4)alkyl when X is a homopolymer, copolymer, a 2 to 20-member heteroalkyl or a 2 to 20-member heteroalkyl substituted as defined above; and

when B is —NH_2, then X is a biradical selected from the group consisting of (C1-C20)alkyl; (C1-C20)alkyl substituted with one or more radicals independently selected from the group consisting of: (C1-C5)alkyl, —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyl radicals, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one of more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(═O)^{R3}, —C(═O)R^7, —OC(═O)(OR^3), —C(═O)(O^-), —C(═O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)R^5, —C(OR^3)(OR^4)(OR^5),

—C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(=NR^1)R^2, —C(=O)(NR^1R^2), —N(C(=O)(R^1))(C(=O)(R^2))(R^3), —O(CN), —NC(=O), —ONO_2, —CN, —NC, —ON(=O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(=O)R^1, —S(=O)(=O)(R^1), —S(=O)(OH), —S(=O)(=O)(OH), —SCN, —NCS, —C(=S)(R^1), —PR^1R^2, —P(=O)$(OH)_2$, —OP(=O)$(OH)_2$, —OP(=O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); a 2 to 20-member heteroalkyl; a 2 to 20-member heteroalkyl substituted with one or more radicals independently selected from the group consisting of: —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyls, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one or more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(=O)R^3, —C(=O)(R^7), —OC(=O)(O)R^3, —C(=O)(O—), —C(=O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)(R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(=NR^1)(R^2), —C(=O)(NR^1R^2), —N(C(=O)(R^1))(C(=O)(R^2))(R^3) —O(CN), —NC(O), —ONO_2, —CN, —NC, —ON(=O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(=O)(R^1), —S(=O)(=O)(R^1), —S(=O)(OH), —S(=O)(=O)(OH), —SCN, —NCS, —C(=S)(R^1), —PR^1R^2, —P(=O)$(OH)_2$, —OP(=O)$(OH)_2$, —OP(=O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2);

R^1, R^2, R^3, R^4, R^5 and R^6 are radicals independently selected from the group consisting of H, (C1-C20) alkyl, (C6-C12)aryl(C1-C20)alkyl and (C6-C12)aryl;

R^7 is halogen;

2 to 20-member heteroalkyl represents a known non-polymeric C-heteroalkyl radical consisting of from 2 to 20 members where at least one of the members is O, S or NH, and the remaining members are selected from CH, C(=O) and CH_2; and (C5-C12)aryl represents a ring system from 5 to 12 carbon atoms, the system comprising from 1 to 2 rings, where each one of the rings forming the ring system: is saturated, partially unsaturated or aromatic; and is isolated, partially or totally fused.

2. The lubricating composition according to claim **1**, wherein

A is OH;

X is a biradical selected from the group consisting of (C1-C20)alkyl; (C1-C20)alkyl substituted with one or more radicals independently selected from the group consisting of: (C1-C5)alkyl, —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyl radicals, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one of more (C1-C4)alkyl radicals, benzyl substituted with one or more halogen radicals, —C(=O)R^3, —C(=O)R^7, —OC(=O)(O)R^3, —C(=O)(O~), —C(=O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)R^5, —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N*$R^1R^2R^3$, —C(=NR^1)R^2, —C(=O)(NR^1R^2), —N(C(=O)(R^1))(C(=O)(R^2))(R^3), —O(CN), —NC(=O), —ONO_2, —CN, —NC, —ON(=O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(=O)R^1, —S(=O)(=O)(R^1), —S(=O)(OH), —S(=O)(=O)(OH), —SCN, —NCS, —C(=S)(R^1), —PR^1R^2, —P(=O)$(OH)_2$, —OP(=O)$(OH)_2$, —OP(=O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); a 2 to 20-member heteroalkyl; a 2 to 20-member heteroalkyl substituted with one or more radicals independently selected from the group consisting of: —OH, halogen, phenyl, phenyl substituted with one or more (C1-C4)alkyls, phenyl substituted with one or more halogen radicals, benzyl, benzyl substituted with one or more (C1-C4)alkyls, benzyl substituted with one or more halogen radicals, —C(=O)R^3, —C(=O)(R^7), —OC(=O)(O)R^3, —C(=O)(O~), —C(=O)(O)R^3, —OR 3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4) (R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N*$R^1R^2R^3$, —C(=NR^1)(R^2), —C(=O)(NR^1R^2), —N(C(=O)(R^1))(C(=O)(R^2))(R^3), —O(CN), —NC(O), —ONO_2, —CN, —NC, —ON(=O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(=O)(R^1), —S(=O)(=O)(R^1), —S(=O)(OH), —S(=O)(=O)(OH), —SCN, —NCS, —C(=S)(R^1), —PR^1R^2, —P(=O)$(OH)_2$, —OP(=O)$(OH)_2$, —OP(=O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2); and a homopolymer or copolymer comprising a polymeric chain selected from the group consisting of: alkyd resin, epoxy resin, phenolic resin, polyvinyl halides, polyacetal, polyacrylics, polyalkylenes, polyalkenylenes, polyalkynylenes, polyamic acids, polyamides, polyamines, polyanhydrides, polyarylenealkylenes, polyarylenes, polyazomethines, polybenzimidazoles, polybenzothiazoles, polybenzyls, polycarbodiimides, polycarbonates, polycarbones, polycarboranes, polycarbosilanes, polycyanurates, polydienes, polyester-polyurethanes, polyesters, polyetheretherketones, polyether-polyurethanes, polyethers, polyhydrazides, polyimidazoles, polyimides, polyisocyanurates, polyketones, polyolefines, polyoxyalkylenes, polyoxyphenylenes, polyphenyls, polyphosphazenes, polypyrroles, polypyrrones, polyquinolines, polyquinoxalines, polysilanes, polysilazanes, polysiloxanes, polysilsesquioxanes, polysulfides, polysulfonamides, polysulfones, polythiazoles, polythiomethylenes, polythiophenylenes, polyureas, polyurethanes, polyvinyl acetals, polyvinyl butyrals, polyvinyl formals, polyvinyl alkanoates, vinyl polymers, and natural polymers;

B is a radical selected from the group consisting of: H, —OH, halogen, phenyl substituted with one or more halogen radicals, benzyl substituted with one or more halogen radicals, —C(=O)R^3, —C(=O)R^7, —OC(=O)(O)R^3, —C(=O)(O~), —C(=O)(O)R^3, —OR^3, —CH(OR^3)(OR^4), —C(OR^3)(OR^4)(R^5), —C(OR^3)(OR^4)(OR^5), —C(OR^3)(OR^4)(OR^5)(OR^6), —NR^1R^2, —N+$R^1R^2R^3$, —C(=NR^1)(R^2), —C(=O)(NR^1R^2), —N(C(=O)(R^1))(C(=O)(R^2))(R^3), —O(CN), —NC(=O), —ONO_2, —CN, —NC, —ON(=O), —NO_2, —NO, —C_5H_4N, —SR^1, —SSR^1, —S(=O)(R^1), —S(=O)(=O)(R^1), —S(=O)(OH), —S(=O)(=O)(OH), —SCN, —NCS, —C(=S)(R^1), —PR^1R^2, —P(=O)$(OH)_2$, —OP(=O)$(OH)_2$, —OP(=O)(OR^1)(OR^2), —B(OH), —B(OR^1)(OR^2) and —B(OR^1)(R^2).

3. The lubricating composition according to claim **1**, wherein the metal chalcogenide is a Molybdenum chalcogenide of sulfide, selenide or telleride.

4. The lubricating composition according to claim **1**, wherein the metal chalcogenide is MoS_2.

5. The lubricating composition according to claim **1**, wherein the nanoobject of the invention is MoS_2 functionalized with polyalkylene glycol.

6. The lubricating composition according to claim **1**, which is a OW-12 grade type having a kinematic viscosity measured at 100° C., according to ASTM D445 standard, higher or equal to 1.5 mm^2/s and less than 9.9 mm^2/s.

7. The lubricating composition according to claim 1, further comprising additives.

8. The lubricating composition according to claim 1 comprising:

at least a base oil;

0.1 to 5% by weight of a least an active ingredient of nanoobject according to the invention;

at least one dispersant.

9. A process for reducing frictions of mechanical parts in an engine comprising at least one step of bringing the mechanical parts of the engine into contact with the lubricating composition according to claim 1.

10. A process for reducing fuel consumption of an engine comprising at least one step of bringing the mechanical parts of the engine into contact with the lubricating composition according to claim 1.

11. A process to improve fuel economy of an engine comprising at least one step of bringing the mechanical parts of the engine into contact with the lubricating composition according to claim 1.

12. A method for improving the fuel economy properties of a composition of 0W-12 type comprising the step of adding in the composition nanoobject as described in claim 1.

13. The lubricating composition according to claim 1, wherein the composition comprises at least 50% by volume of base oils, based on the total mass of the composition.

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